G. M. Allen in Brazil. Together with this he also obtained the following records.

Strophocheilus yporanganus, Pils. & v. Iher. Yporanga, Sao Paulo, Brazil. M. C. Z. 79107.

Oxystyla pulchella prototypus, Pils. Ribeira Creta, Brazil. M. C. Z. 79109.

Thaumastus largillierti, Phil. Yporanga, Sao Paulo, Brazil. M. C. Z. 79110.

FRESH-WATER MOLLUSKS IN BRACKISH WATER AND IN MARINE AND BRACKISH-WATER FORMATIONS

BY JUNIUS HENDERSON

I am much interested in the report (THE NAUTILUS, XLII, 129-130, 1929) of experiments on the resistance of *Physa* and *Lymnaea* to salinity, but the brief report does not throw any light upon two very important problems, namely: How long can these mollusks continue to live in brackish water? Can they successfully breed and continue to thrive under such adverse conditions? If so, then it seems that it should not be difficult to find them actually living under such conditions in some of the many estuaries where slight salinity is produced by mingling of tide water with fresh-water streams. In any event, let us hope the experiments may be continued for a term of years and see what might be possible, whether the same thing is known to occur in nature or not.

In collecting fresh-water mollusks along the Pacific Coast from California to Alaska, including Naiades, Sphaeriidae, *Fluminicola*, *Goniobasis*, *Lymnaea*, *Valvata*, etc., I have often watched for the point at which they disappeared in following streams down to their meeting with tide water and have never found any of them living where I could detect any taste of salt in the water. On some occasions my attention was called to the fact that I was ap-

proaching the ocean, while it was yet far away, by the disappearance of these mollusks, which was apparently due to a slight mingling of tide water, at the head of its flow, with stream water. Possibly the experience of others has been different.

Occasionally a few fossil mollusks supposedly of strictly fresh-water habit are found mingled with a brackish-water or marine fossil fauna. If the fauna is marine, then almost certainly the occurrence of the fresh-water fossils is "accidental", they having perhaps been carried into the ocean by floods from neighboring streams or brought in by some other natural agency. If it is a brackish-water fauna the same explanation is likely correct, though it certainly would depend upon the degree of salinity of the water during deposition and the adaptability of the mollusks to saline conditions. Hence a thorough investigation of this whole problem in all its phases, continuing through several years, is desirable, if it has not yet been accomplished.

It is not uncommon to find a few fresh-water fossil mollusks in the various brackish-water formations of the Rocky Mountain region, but in no case which has come under my own personal observation have the fresh-water and brackish-water species actually occupied the same stratum. Their occurrence has indicated alternating brackish and fresh-water conditions, not a mingling of the two faunas during life.

Dr. Dall, in his great work on the Tertiary Fauna of Florida, lists certain supposedly fresh-water species with marine faunas in such a way as to indicate that they were really marine, which inference he probably did not intend. It is probable that they were accidental intruders brought in by floods or floating drift-wood, or in some such way. Even land snails may easily fall or be washed from sea cliffs into the ocean and become incorporated in strictly marine deposits.

I once found a small but rich deposit of *Physa, Plan-*

orbis and *Lymnaea* apparently in a marine Pleistocene formation in a California sea cliff. Careful investigation proved conclusively that the fresh-water mollusks had lived in a small stream channel cut in the marine formation after it was elevated above the tide, and the channel had afterwards been filled to a level with the general surface of the elevated marine beds. The foregoing are only a few of the many difficulties that beset the paleontologist.

FURTHER RECORDS OF WESTERN CANADIAN MOLLUSCA

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This paper is one of a series dealing with the distribution of the Western Canadian mollusca (see NAUTILUS, XXXIX, pp. 121-128; XL, pp. 54-63; XLII, pp. 13-18). In the course of this work many observations have been made on other phases of the biology of these forms, but the information thus collected is reserved for subsequent publication in more comprehensive form. In all these papers an effort has been made to render the citation of the records as concise as possible, but at the same time to have them sufficiently definite to avoid misunderstanding.

The discovery of living molluscs (*Lymnaea vahlii*) in the waters of Little Quill Lake, Saskatchewan, is of some interest, since this is a highly alkaline lake. An analysis is given below.